Functional Graded Thermal Barrier Coatings for F402 Turbine Engine Components

Status: Technical Success

PROBLEM / OBJECTIVE

High Pressure Turbine (HPT) Nozzle Guided Vanes (NGV) for the F402 Pegasus Rolls Royce Engine experience half the expected 2000-hour design hot section life, leading to unscheduled inspections and maintenance repairs. This increases operations and support (O&S) costs and reduces aircraft readiness for both the Navy and Marine Corps.

Thermal barrier coatings have been identified as a solution to meet engine design parameters. Project testing has shown marked improvement relative to protecting engine components. Following NAVAIR review of this effort, a determination will be made relative to further testing, application and implementation on subject engine models.

ACCOMPLISHMENTS / PAYOFF

Process Improvement:

An electron beam physical vapor deposition (EB-PVD) coating technique was used to apply a ceramic thermal barrier coating (TBC) on engine hardware. A simple coating process methodology was developed to produce a micro structural modification within the TBC, resulting in a substantial reduction in thermal conductivity of the ceramic, as well as increased hemispherical reflectivity, and increased thermal cyclic oxidation life under aggressive high temperature cyclic oxidation conditions and increased TBC strain tolerance.

Implementation and Technology Transfer:

As part of the implementation process, TBC-coated engine vanes were coated and tested by Rolls Royce in an Accelerated Simulated Mission Engine Test (ASMET). At the 500 hour mark, the engine sustained damage when molten particles from the compressor section entered the stator vane section. Resulting damage resulted in the termination of the test. Post-test evaluation indicated the TBC-coated components performed well in service. Additional testing is still required before implementation can move forward.

Electron Beam Physical Vapor Deposition Advanced Coating Unit

Expected Benefits:

- Life cycle cost savings approximately $40.8M over 20 years (reduced O&S costs).
- Achieve engine design life parameters. (performance enhancement)
- Micro structural modification can be extended into next generation Navy/DoD/commercial aircraft engines (Joint ness).

TIME LINE / MILESTONE

Start Date: February 20 2000
End Date: June 30 2005

FUNDING

Total ManTech Investment: $1.73M
Cost Share (NASA-GRC): $0.5M testing
Cost Share (NAVAIR): $1.05M Engine Testing

PARTICIPANTS

Rolls Royce
NASA-GRC
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NAVAIR 4.4
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